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An Automated System for the Analysis of Combat Training Center Information: Strategy and Development

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U.S. Army Research Institute

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This report explains the rationale for and development of automated systems for the analysis of Combat Training Center archive information. Such systems are justified in terms of need, reuse, and technological advances in computer hardware and software. The Automated Force Concentration Measurement System, which serves as an example of a successfully developed system, illustrates the advantages of the approach using data from National Training Center simulated combat field training exercises. The system efficiently replicates earlier research findings regarding the massing of attacking forces.

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Education and Training Technology

FOREWORD

A primary mission of the U.S. Army Research Institute for the Behavioral and Social Sciences is to find ways to improve Army training. The application of technological developments to training is one of those improvements. Advances in computer hardware and software at diminishing cost have opened up new opportunities for computer-based analysis. A strategy for efficient exploitation of the Combat Training Center archive and recent technology using automated analytical systems is presented. In addition, a successful example of such a system is described based on earlier research dealing with the relationship of massing of combat power to unit performance.

EDGAR M. JOHNSON
Director

AN AUTOMATED SYSTEM FOR THE ANALYSIS OF COMBAT TRAINING CENTER INFORMATION: STRATEGY AND DEVELOPMENT

EXECUTIVE SUMMARY

Requirement:

Field training exercises at the Combat Training Center generates a growing wealth of information. A significant need exists to determine how this information can be used to benefit the Army in an era of diminishing resources.

Procedure:

The report describes a strategy for developing automated analysis systems based on technological advances in hardware and software. An example of such a system, the Automated Force Concentration Measurement System, is defined, developed, and tested.

Findings:

The potential for automated analysis of data from the Combat Training Centers was successfully demonstrated. The Automated Force Concentration Measurement System produces a range of measures comparable to earlier research, but does so much more efficiently. The results of a tryout using recent data from the National Training Center cross-validates previous research findings.

Utilization of Findings:

The Automated Force Concentration Measurement System is available for Combat Training Center archive users for a variety of research and analytical purposes. The description of the methodology presented here illustrates an approach to the development of other automated analysis systems. This methodology should prove invaluable in enabling greater utilization of archive information with fewer resources.

AN AUTOMATED SYSTEM FOR THE ANALYSIS OF COMBAT TRAINING CENTER INFORMATION: STRATEGY AND DEVELOPMENT

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AN AUTOMATED SYSTEM FOR THE ANALYSIS OF COMBAT TRAINING CENTER INFORMATION: STRATEGY AND DEVELOPMENT

Introduction

Information is the proverbial high ground for today's Army. How a force manages its informational assets may be the critical difference between a successful operation and something less. From one perspective this is not new, intelligence in military operations has been known to be critical since ancient times. What is different today is the volume of information available to commanders and the fact that much of the information is collected, stored and communicated via machines, especially electronic digital computers. The information age may be characterized by the critical importance of speed, including speed of information use (Sullivan and Dubik, 1994).

Not only is the management of information vital for actual military operations, it is also important during activities such as training and maintaining force readiness. Use of information for such purposes includes training feedback. Identified training deficiencies can be subsequently corrected, and areas of training strength can be sustained.

Army units train to operate in a combined arms and services environment. Army Combat, Combat Support and Combat Service Support branches must function together in a highly integrated manner to survive on the battlefield and accomplish the mission, including military operations other than war. To effectively and efficiently prepare for complex operations requires extensive training in a simulated combat environment.

The Army conducts collective training operations at several Combat Training Centers (CTCs). The National Training Center (NTC) is the Army's prime facility for large-scale armor and mechanized infantry combat training. It is the oldest and the most developed of the Combat Training Centers, located in the Mojave desert at Fort Irwin near Barstow, California. The NTC consists of over 1,000 square miles of terrain accommodating large maneuver and live-fire exercises plus nap-of-the-earth flying, firing of air defense weapons and practice in the use of electronic warfare.

Since 1981, training at the NTC has focused on the level of the battalion task force but has recently expanded to include support for brigade operations. A permanent Opposing Force, a full-time cadre of observer-controllers consisting of carefully chosen commissioned and noncommissioned officers, and an instrumented simulated battlefield (Sulzen, 1986) contribute to the realism and high quality of the training which the visiting unit experiences at the NTC. Extensive training feedback and analysis are provided to maximize the improvement in tactical capability. The performance of units at the NTC is also used to provide senior commanders a measure of the Army's readiness for combat (U.S. Government Accounting Office, 1991).

Training operations at the NTC have been important in identifying common training deficiencies among Army units (U.S. Government Accounting Office, 1984) and in providing a data source upon which to base improvements in training, organization, equipment and operational doctrine. The Army Research Institute (ARI) has developed an archive of information generated by these training exercises conducted at the Combat Training Centers (Hamza, in preparation). ARI formulates methodologies for utilization and supports a wide range of analyses conducted with sponsorship of interested agencies throughout the Army and other military services as well as non-defense agencies.

One of the challenges of Army training is how to exploit modern technological advances to improve the effectiveness and efficiency of training. Recently, significant advances have been made in informational sciences which offer important contributions to Army training.

Unique Data

The CTCs are a unique and rich source of information for understanding what is the current status of the Army, for determining how it can be improved, and for establishing relationships among factors and outcomes. For example, how Army training resource levels contribute to operational effectiveness was shown using data from the NTC (Hiller, McFann and Lehowicz, 1994). Another major study investigated longitudinally how training practices at home station impact the performance of units when they trained at the NTC (Holz, Hiller and McFann, 1994).

The volume of information flowing from the CTCs into the research archive has increased over the years. This has been the result of both an increasing realization of the value of secondary data elements and standardization of procedures at the CTC. The consequence of these two phenomena is a convergence resulting in large and increasing quantities of material being archived. The magnitude of the effort to use the archive has grown. Not only has the work of cataloging, indexing, digitizing and developing databases increased, but more analyses to benefit the Army are needed.

Computer-Assisted Analytical Tools

A primary strategy used in improving the usability of the archive is the development of computer-assisted analytical tools. The concept behind these software tools is that they are intended to be used by an analyst or researcher, independent of the archive support staff, to assist in performing a particular analytical task. One of the early examples was a cataloging system that showed information holdings of the archive organized by CTC and by training event (Shillcock and Nichols, 1991). Although plans exist for its revision, the original program is still used, nearly a decade after its initial development. Another example of an automated analytical tool was the General-purpose NTC Analysis of Training Tool (Goehring, 1989a). This system was developed to enable the instrumented data from training exercises at the NTC to be replayed by an investigator on low-performance, widely-available MS-DOS computers for a wide range of analytical purposes. A battle replay system based directly on this concept but with enhanced capabilities is currently a part of the archive support software.

Development of these analytical tools is often a resource intensive undertaking. The justification in the investment is that once a tool has been developed, it can be employed repeatedly by a large number of archive users. The goal behind the development of such tools is to serve the analytical needs of the archive user. This frequently referenced "user" is not easily defined or characterized, having in fact ranged from junior non-commissioned officers to retired general officers on the military side and from agency representatives through graduate-student and doctoral-level researchers. More than three hundred individuals from dozens of government agencies have traveled to the archive to be trained and certified in its use in a series of specially designed workshops (Goehring, 1989b).

There are two current problems attendant to the tools development approach. First, there are currently fewer resources available to develop these. Second, due to diminishing resources, there are fewer investigators available to employ the tools that have been or may be developed. This leads to the necessity of becoming increasingly selective about which tools to develop. While the very nature of research makes it difficult to anticipate what types of information researchers and analysts will pursue, particularly using an information source as rich and complex as the CTC research archive, at times it may be difficult to justify the resources for the development of new software tools.

Automated Analysis

There is another class of software tool development which may ameliorate some of the problems of the previous approach. In one sense it is a refinement of the software tools development concept, yet it is simultaneously different in scope. Once a need for a computer-assisted tool has been identified, a software tool can be developed to meet that need and to extend the analytical capabilities of the researcher or analyst, allowing more work to be accomplished with much fewer resources.

What distinguishes this approach from previous software tool development efforts is that most of the work of the researcher or analyst is actually accomplished by the computer software. After careful formulation of the problem and codification, the actual analysis is accomplished automatically. The difference from the past is somewhat subtle. Previously, software tools processed and presented refined information to the investigator, who then further analyzed the information. Now because of several technological developments it is increasingly possible for much of the second phase of the work to be accomplished fully automatically. In the first case, the computer helped to do the work. In the second case, the computer does all the work!

This has become possible through the development and availability of inexpensive computer technology. Today an investigator can have in a desktop computer, the computational power comparable to a mainframe of a decade ago. Further, and in many ways more important, the software capabilities for getting that hardware working on the investigator's problem is greatly superior to that of a decade ago. The software is both more powerful and easier to use. These developments have created tremendous technological leverage which is available for application to automated analysis of CTC research archive information.

Automated systems are here today to meet the challenge of increasing amounts of information and diminishing resources for extracting meaning from that information. The next section of this paper presents a case in which this technological leverage has been successfully employed

A Case Study: Measuring Attacking Unit Massing

The highly realistic simulated combat environment of the NTC (Shadell, 1989) offers unique opportunities for investigating the effectiveness of ground combat tactics. Of particular interest are force-on-force battles in which an Army unit being trained plans and carries out a attack against a defending unit. These battles are relatively simple tactically in comparison to most other types of missions used for NTC training. Further, deliberate attack missions are also numerous in the NTC data archive. Both the relative tactical simplicity and the abundance of deliberate attack battles facilitate their use in the search for predictors of tactical performance effectiveness.

A commander must visualize the battlefield accurately in order to be successful. How these visualizations, mental representations or images of commanders are formed, modified and utilized are subjects of considerable interest to military trainers, analysts and planners (Kahan, Whorley & Stasz, 1989). Among the paradigms used in this context are the Principles of War and Tenets of Army Operations (Headquarters, Department of the Army, 1993). Included are imperatives to military commanders, such as to synchronize and mass forces at critical locations and times on the battlefield while retaining flexibility and agility to exploit any weaknesses of opponents.

Obtaining criterion performance measures of units is demanding of both time and resources, especially subject-matter expertise. NTC training exercise analysis would benefit greatly if unit performance measures could be generated with a minimum of human effort. One solution is the development of completely objective calculation procedures of performance criteria. Such measures would be both inexpensive to apply to battles and highly objective. Ideal criteria would be free of potential distortions of subjective methods, such as hindsight bias (Fischhoff, 1975), where observers are found to completely unable to make objective judgments when they know what outcome resulted.

In the NTC environment, the concepts of mass and agility are used by exercise controllers and by commanders when describing force-on-force attack battles. Crouch and Morley (1989) discussed these concepts in the context of NTC and found that a higher degree of force massing and greater speed of maneuver were related to success in attack battles. They inferred these findings from their observations rather than basing them on systematically collected data.

Several attempts to employ NTC data to explore relationships between tactical procedures of units and their performance have met with limited success. Parker (1990) and Stafford (1990) both indicated a need for improved NTC data quality. Dryer (1989) had greater success employing NTC data when he developed a measure related to mass. He defined Ground Force Concentration geometrically in terms of the size of a circle with its origin at the center of the defensive position at a particular time in the battle (the critical ground force attrition time). When the magnitude of the size of this circle is such that it encompasses the locations of 25 percent of the attacking force combat power, a statistic he termed rQ(25) is defined. A unit's combat power is defined as its number of tank and tank-killer weapon systems. He found the rQ(25) measure was predictive of the performance of attacking battalion task forces.

The performance criterion Dryer used was attrition-based, combining measures of the destruction of the defending force combat power and the survival of the attacking force combat power. The combat power, at the start of the battle was used as a basis for calculating the percentage of combat power loss during the exercise independently for the attacking and defending forces. The performance criterion resulted from finding the arithmetic mean of the percentage of defending force losses and of the percentage of attacking force survival (100 minus the percentage of its combat force loss). The required inputs were extracted from written take-home package statistics of units trained at NTC.

The detailed calculation of Dryer's Ground Force Concentration measure is complex, resource intensive and not reasonable to fully replicate. He used mainframe computer plotting methods to generate relative attrition density plots and to identify the critical ground force attrition time. Further, close inspection reveals both his method for locating the center of the defensive position as subjective, and his treatment of data for combat power which is distant from the vicinity of the battle as ambiguous.

The goal of Goehring and Sulzen (1994) was to replicate the work of Dryer (1989) using data from an independent sample of NTC battles and then to develop a related measure, which could be readily calculated in an MS-DOS computer environment. They focused their attention on 23 NTC attack battles with extremes of performance. For each of these battles a measure of Ground Force Concentration which is very similar to that of Dryer was calculated. The method is consistent with Dryer's definition but without using the mainframe software. This Ground Force Concentration measure, like Dryer's, requires identification of the center of the defending position and of the critical ground force attrition time.

Two raters independently viewed each battle on MS-DOS battle replay software and estimated the center of the defending position and identified its map coordinates.

There was reasonable consistency between these sets of points so they were averaged.

Dryer defined the critical ground force attrition time in the battle when 25 percent of the attacking force losses had occurred. Each battle was again replayed to determine when the attackers began their movement towards the defenders. When 25 percent of the attacking force losses had occurred, that time was recorded as the critical ground force attrition time.

The critical ground force attrition time and the center of the defensive position parameters, as developed above, were used to calculate the value for the rQ(25) measure of Ground Force Concentration based on the instrumented NTC player location data. This measure of Ground Force Concentration was then correlated with the performance measure. These data failed to show the expected relationship between the variables. Sampling variability, procedural differences, or a combination may account for this failure to replicate Dryer's findings.

Exploring alternative calculations of Ground Force Concentration with respect to the location of the defending force, Goehring and Sulzen next conceptualized the attacking force as continuously being massed to a greater or lesser extent. Retaining the general idea of the measure of dispersion based on a median calculation seemed sound as it finesses certain position-location loss problems as well as determinations of precisely which players are active participants in the battle. Goehring and Sulzen, therefore, set out to define a modified measure of Ground Force Concentration, termed dynamic concentration.

First, the median task force location in the attacking force was calculated throughout the battle by finding the median Easting location and the median Northing location of all attacking force tank and tank-killer vehicles. The concentration of these vehicles of the attacking force was then defined, based upon their dispersion with respect to the median task force location, as the size of a circle which includes 25 percent of these players at each point in time during the battle. This measure of Ground Force Concentration, defined continuously throughout the battle, was termed the dynamic rQ(25).

Each battle in the sample was again examined to determine when the main element of the attacking force approached to within three kilometers of the defending forces. The critical minimal dispersion point was defined as the minimum dispersion value, measured by dynamic rQ(25), occurring within thirty minutes following the approach of the main element of the attacking force within three kilometers of the defending force, based on the maximum effective range of direct fire weaponry.

Goehring and Sulzen (1994) found that the dynamic rQ(25) measure of Ground Force Concentration at the critical minimal dispersion point is predictive of the attrition-based performance measure for battalion-level attack battles ($r = -.38$, $p < .05$, $n = 23$). The magnitude of the obtained Pearson Correlation Coefficient does not differ significantly ($Z = 1.16$, $p > .1$) from Dryer's finding, but the samples are small. These results, using NTC data, are therefore consistent with Dryer's findings, showing that measurable Ground Force Concentration of an attacking task force is predictive of the unit's performance effectiveness.

The objectives of confirming Dryer's findings and of calculating a comparable measure using an MS-DOS computer were achieved in deriving the dynamic rQ(25) measure of Ground Force Concentration, but it did not achieve the freedom from subjective judgment that had been sought. Specifically, the data from each battle had to be carefully viewed several times using the battle replay system to determine the location of the defending force and when the attacking task force approached to the three km point from the defensive force. Therefore, the researchers proceeded to develop more objective metrics of defending force location and of the proximity of the attacking and defending forces.

Because the median location of the attacking force had proven useful, the median location of the defending force was also calculated. In doing so, only vehicles within ten kilometers of the center of the battlefield were categorized as within the range of influence of the battle. Vehicles more distant were ignored. The center of the battlefield was defined as the point midway between the attacking and defending median locations.

Because of the heterogeneity of battlefield sizes and shapes, Goehring and Sulzen employed a general measure of the proximity of the attacking and defending forces. The computer calculated the Ground Force Concentration using the minimum dynamic rQ(25) value for the attacking force while the distance between the attacking and defending forces ranged from eight to four kilometers. Three of the 23 battles in the sample were found to be unusable because the forces were too close together at the start to employ the metric.

This computer calculated rQ(25) measure was predictive of the performance of attacking battalion units ($r = -.39$, $p < .05$, $n = 20$). In addition, the comparable value for a circle encompassing 75 percent of the attacking unit's combat power, rQ(75), was also predictive of performance ($r = -.39$, $p < .05$, $n = 20$), and the comparable value for a circle encompassing 50 percent of the attacking unit's combat power, rQ(50), was suggestively related to performance although not at a statistically significant level ($r = -.29$, $p = .11$, $n = 20$).

Following this demonstration of the research utility of the concept of measuring the mass of forces in simulated combat training, the potential was realized of the force concentration measure as a candidate for the development of an completely automated system—rather than simply a computer-assisted system—for the analysis of CTC information. The general goal of the work reported below was to produce a fully automated system to perform an important but otherwise resource intensive analysis of complex and voluminous information.

Project Objectives

The objectives of the Automated Force Concentration Measurement System (AFCMS) were several. The first was develop the computational functionality demonstrated in the work of Goehring and Sulzen (1994) into a concise, complete software package that can be used with the CTC research archive by any investigator. The second objective was to develop the system rapidly and inexpensively using off-the-shelf software. Finally, the intention was both to extend the functionality of the system to encompass as much data from the archive as possible and to make the resulting system as easy to use as possible.

The AFCMS needed to reproduce the measures of concentration which had been validated in the previous work for predicting the performance of units. In addition, several additional descriptive statistics could be simultaneously produced since the required variables are present in the input data source. Desired statistics included: (1) the Force Ratio of the combat power of the attacking force relative to the defending force, (2) the attrition-based performance of the attacking unit (Goehring and Sulzen, 1994), and (3) the Casualty Exchange Ratio (Hiller, McFann and Lehowicz, 1994).

The AFCMS system was designed to place the archive user in control. It was intended to automate calculations for the investigator, but was not intended to usurp any of the responsibilities or decisions of the investigator. The system calculates automatically but does not replace the experience and judgment of the investigator. Supporting this objective, there are several AFCMS options available to the investigator. The options provided are used to delimit the data or to accommodate unique situations (See Appendix A for presentation of AFCMS controls and options).

The system is intended to be easy to learn and to use. For this reason the familiar and widely available Windows™ graphical user interface was selected as the target operating system. This decision was also important from a design perspective, indirectly solving many otherwise troublesome development problems such as screen resolution and printer support. Such matters are determined by the installation of Windows on the investigator's hardware system and thus transparent from the perspective of the AFCMS.

The original development and validation research (Goehring and Sulzen, 1994) employed a sample of early NTC data. More recent data has since become available, although its format is different. The design decision was made to enable the AFCMS to accommodate both early and recent data formats and thus span the entire NTC database of force-on-force missions.

The AFCMS was designed not to require special input. Rather it employs force-on-force training exercise data which is used for battle replay on MS-DOS-based computers. The information in each file includes types of weapons of individual vehicles and time-tagged locations of vehicles as well as engagement data for a single NTC simulated battle. The data for hundreds of these battles are currently available in the research archive.

The AFCMS is designed to be used iteratively on a single battle. Once the battle has been selected, it can be processed using the default AFCMS settings. Occasionally the initial run will produce concentration statistics of zero. Usually this means that the program was not successful in its attempt to identify a meaningful battlefield center because of numerous extraneous vehicles on the NTC terrain. Typically what the investigator must do at that point is to provide the system with an approximate location of the center of the area where the battle takes place. This can usually be determined most easily by viewing the replay of the battle (always highly recommended when analyzing NTC battles).

A minor problem occasionally occurs when there are long periods of minimal activity either before or after the main battle which produces long periods of unchanging data. When this is the case the start time of the battle can be determined from other sources or inferred from the AFCMS graphical display following a data run which shows the distance between the centers of the two forces continuously over time from the start to the end of the processed data. When this graph is flat for long periods it indicates lack of movement between the forces. Specification of start or end times avoids processing of data which is not meaningful to the investigator. After options such as the battlefield center or start/end times have been entered, the AFCMS can be rerun to process the delimited data.

A system for providing help is available to the archive user of AFCMS at any time except while the data are being processed. Thus, if a problem arises, the information needed to proceed is available on-line. The entire help document can be printed using any printer configured as part of the Windows environment (See Appendix A).

Results

After the AFCMS was developed, its operation was first checked using the early data (Goehring and Sulzen, 1994). Next, the system was employed to cross-validate those findings. The analysis that previously had taken weeks was completed using the AFCMS in hours.

Twenty deliberate attack NTC battles from the FY92 and FY93 time period were analyzed using the AFCMS. The attrition-based performance measure was calculated based on NTC Observer/Controller reports of combat power casualty numbers for each battle.

All three of the force concentration measures calculated by AFCMS were in the predicted direction. The measures rQ(25) ($r = -.449$, $\underline{p} < .05$, $n = 20$) and the rQ(50) ($r = -.436$, $\underline{p} < .05$, $n = 20$) were significantly correlated with attrition-based performance of the attacking forces, while the relationship of the rQ(75) measure to performance was not statistically significant. Examination of the data graph of rQ(25) force concentration values plotted against performance values (See Figure 1) suggests that units with the highest concentration of their combat power had high performance about half of the time, while those units with the lowest concentration of forces had consistently low performance. These findings confirmed that force concentration appears to be necessary but is not sufficient for high performance. When all three measures were input into a stepwise multiple regression using conventional tolerance levels, only rQ(25) was entered into the prediction equation. Thus, these three variables are highly redundant in what they measure.

The AFCMS performed satisfactorily during this test. It is now a completed tool, available to investigators who wish to employ the measures of force concentration as a predictors, or even as criteria. For example, to use the measures as a criteria it would be of interest to examine the types of training at home station of units that were able to concentrate their forces and how these methods differed from

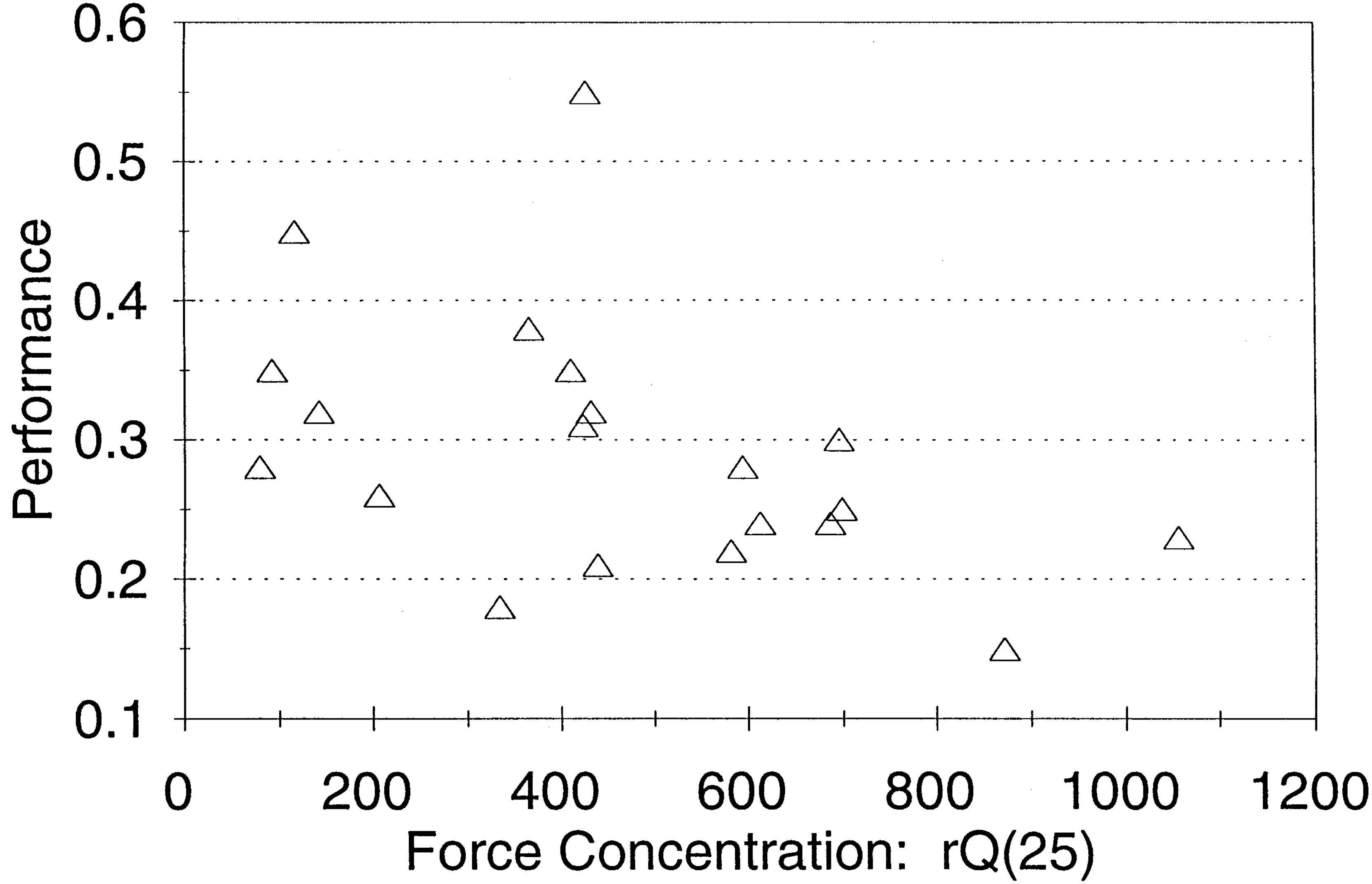

Figure 1. Relationship of force concentration, measured by rQ(25), and performance of attacking task forces during FY92-93 at the NTC.

units not able to concentrate forces. Use of the system with the new data sample also provides further validation of the idea of using the calculation of the concentration of the attacking force as an operational definition of massing of combat power.

Discussion

The successful development of the AFCMS demonstrates how automated tools can leverage the analytical power of an investigator of the CTC research archive. Following this example it will be possible to identify similar and more involved applications of the analytical strategy to the development of additional automated analytical tools to increase the productivity of archive investigators. The general methodology demonstrated here can be applied immediately to other analytical problems.

The instrumented data from the NTC, and the other CTCs as it becomes available, are a unique and incredibly valuable source of information to develop and unobtrusively test operational as well as theoretical ideas. For example, the idea of effectiveness of a unit as a function of local versus global force concentration might be examined using NTC data. Such an investigation could use this automated analytical approach for rapidly examining a large number of local battle situations.

A more operationally oriented investigation might, for example, involve the development of an automated system to explore the proximity and timing of supply resources to the locations and events of combat. Measures could be related to the effectiveness judgments of CTC observer/controllers as recorded and preserved in the training take-home packages. Similarly, much could be learned through a detailed time and distribution investigation of the use of fire support on the simulated battlefield, which could be examined using an automated system similar in principle to the one described.

Conclusions

A strategy for the development of a new class of automated analytical tools has been articulated and demonstrated. This methodology can be both applied directly and extended to other problems. The benefit is essentially analytical leverage, being able to accomplish more work with few resources. As fewer resources of all kinds are likely to be available for analysis in the foreseeable future, methods such as the one presented here need to be extended to achieve greater value from what is available. Expanded use of appropriate automated analytical systems is an effective approach to greater productivity in the analysis of CTC information.

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Appendix A

Guide to Using the Automated Force Concentration Measurement System

Guide to Using the Automated Force Concentration Measurement System

D. J. Goehring, January 1994

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Purpose

The Windows-based Automated Force Concentration Measurement System is designed to perform research-oriented calculations easily and quickly on the data resulting from attack force-on-force training missions conducted at the National Training Center (NTC). This document describes the Automated Force Concentration Measurement System, its features and its use.

Functional Summary

The Windows-based Automated Force Concentration Measurement System supports selection of data files, unpacking and preprocessing of NTC replay system files, selection of parameters including geographical center of the battlefield, start time and end time, alternative proximity radius from the battlefield center for determination of valid players, as well as options for selecting data unpacking, suppression of graphical display, selection of old input data format, and selection of file output.

Use of the System

Familiarity with Microsoft Windows. Use of Automated Force Concentration Measurement System assumes that the user is familiar with the Windows Graphical User Interface at the beginner level or higher. If one is new to Windows then several hours may be necessary acquiring familiarity with use of the mouse, selecting from menus, closing and manipulating Windows and so forth. Manuals and books supporting Windows are excellent and widely available so this should not be a problem for one who wishes to use the Automated Force Concentration Measurement System.

Installing the System. The Automated Force Concentration Measurement System is supplied on a single diskette. Insert the disk in the drive while running Windows 3.1 and then run the setup program. Installation is fully automatic.

Starting the System. To run the Automated Force Concentration Measurement System, find and then double-click its icon from the Windows Program Manager.

Functionalities

Selection of several options is possible from the Startup Window (See Figure 1) once execution of the Automated Force Concentration Measurement System has been initiated.

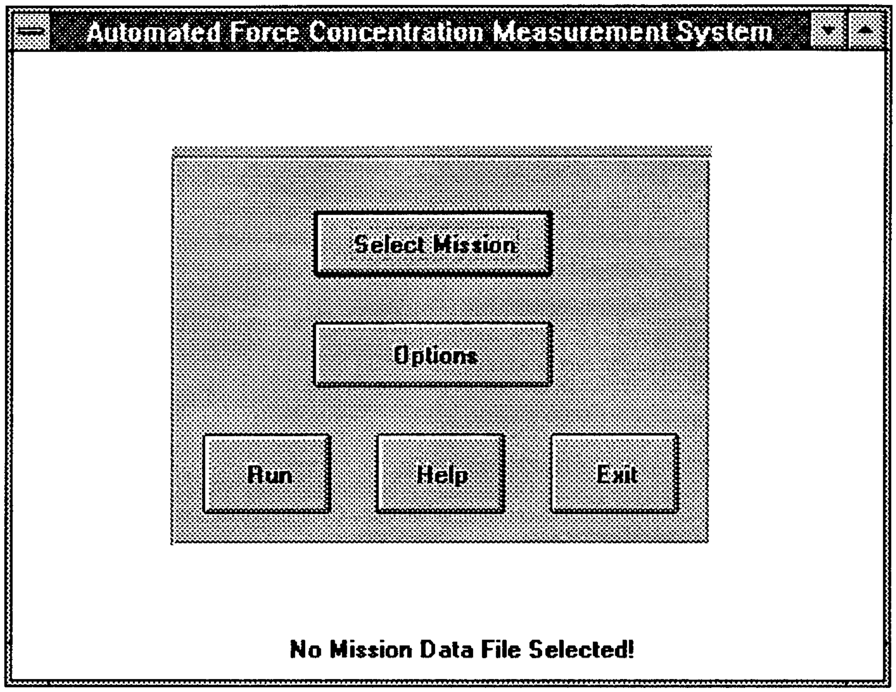

Figure 1. Startup Window

Help. Selection of the Help button will start the Windows Write program and display this document on the screen.

Exit. Selection of this button will cause immediate termination and exiting from the Automated Force Concentration Measurement System.

Selecting Mission Data File. The Select Mission button enables selection of the battle database using standard Windows interface components (See Figure 2). First, the drive should be selected. Then, the directory should be selected. Finally the attack mission data should be selected either in packed form (*.ARC) or in immediate-use form (*.DAT). If the immediate-use form is available then the suppression of unpacking option should be checked from the Options Panel (See Figure 3). Once the mission data has been selected its name will be displayed below the Select Mission window. After selecting the mission data file, the Done button can be selected.

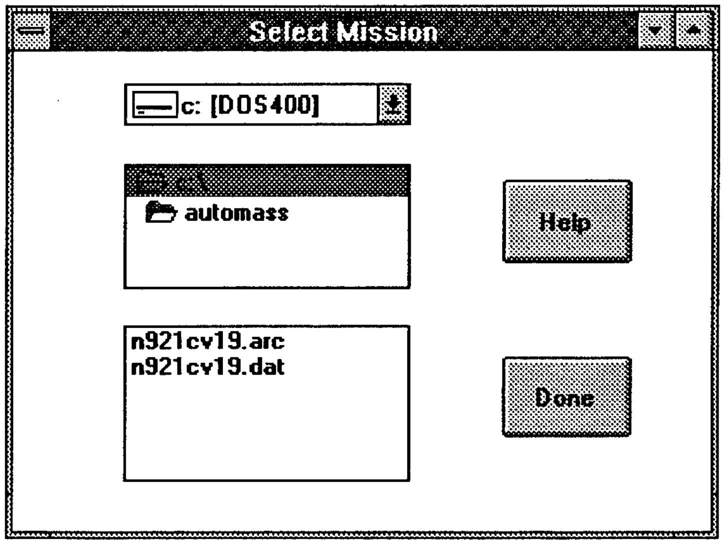

Figure 2. Mission Selection Window

Choosing options. The Options button brings up the Options Panel (See Figure 3). Here a variety of selections can be made using the mouse to click each item. For some items selected, parameter values will be requested when the Done button is chosen. Each option is discussed in detail below in the features section.

Running. Selection of the Run button will cause the selected data to be read and processed according to options from the option menu.

Results. The result of running the Automated Force Concentration Measurement System will depend on selections made on the Options Panel. For a detailed discussion see the Outputs section below.

Features

The following is a detailed consideration of each of the options which are supported using Automated Force Concentration Measurement System through use of the Options Panel (See Figure 3).

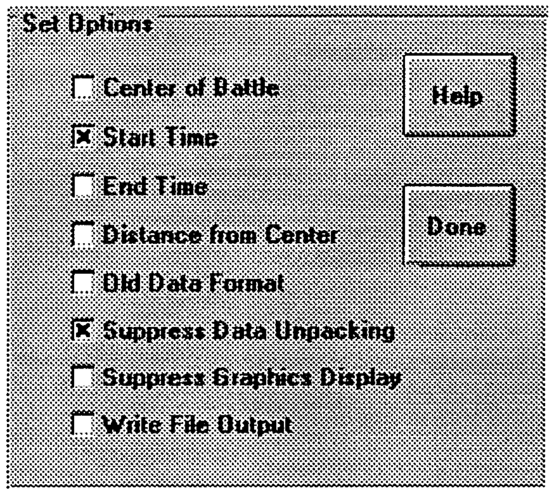

Figure 3. Options Selection Panel

Center of Battle. This parameter is the initial location from which the distance of players is computed. When the value has not been specified the Automated Force Concentration Measurement System will calculate the center of all players in the data for the first time period available. With some data this method works in locating the battle geographically while in others the median location may be far distant from any players, resulting in meaningless calculations.

Start Time. This parameter permits ignoring the beginning portion of data. When the data for a mission contains extensive time periods, sometimes hours, prior to the movement phase of an exercise, it may not be meaningful to perform calculations on that data. By selecting a start time just prior to the coming together of the Task Forces more meaningful results are generated. A battle replay system may be used to determine an appropriate start time. The start time value should be entered in HH:MM format based on a 24-hour clock. If the data in the battle databases transitions midnight this parameter will not work correctly. These data may require editing. If no start time is specified, then data from its beginning is processed through the Automated Force Concentration Measurement System.

End Time. This parameter is comparable to the start time parameter but allows data at the end of the data to be ignored. If no end time is specified, then data to the end of the data file is processed through the Automated Force Concentration Measurement System.

Distance from Center. This rarely needed parameter provides an alternative measure for determining the proximity of players to the battlefield center. The default value is 10 kilometers. Only tank-killing combatants within a circle drawn with the radius of this parameter are included in the Automated Force Concentration Measurement System calculations. A typical use of this parameter is to exclude a large group of players who are near the battle but judged to not be a part of it. Use this option when the battle center gets pulled off toward the group of extraneous players. Changing this parameter typically may affect the Automated Force Concentration Measurement System outputs. Typical values of the parameter are 8 or 6.

Old Data Format. Selection of this option accommodates data prepared for the older DOS-based battle replay. This option will not be needed for any NTC battle data generated for FY 91 or after.

Suppress Data Unpacking. Once the data have been used in the Automated Force Concentration Measurement System, this option should be selected. When the immediate-use data is available a *.DAT file is present. This option should then be selected for efficiency. When this option is not selected the Automated Force Concentration Measurement System unpacks the *.ARC file and then preprocesses the *.PLX file into a ready-to-run *.DAT file when the Run button is selected.

Suppress Graphics Display. Selection of this option avoids the processing necessary to produce the output graph showing the distance between the Task Forces as a function of the time intervals in the processed data.

Write File Output. Selection of this option will cause the Automated Force Concentration Measurement System to write both the input parameters and the outputs for the battle to a file MASSOUT.PUT. This information is written to the last line of the file. Values included are the mission identification, date created, specified battle center, proximity parameter, rQ(25), rQ(50), rQ(75), the force ratio, performance index and Casualty Exchange Ratio.

Outputs

Graphical display. This display shows the distance between the centers of the attacking and defending Task Forces for each interval in the data, or between the Start Time and End Time if those parameters where entered. In the ideal NTC attack battle this graph shows a steadily decrease as the Task Forces join. Extended flat portions in this graph suggest rerunning the data using Start or End parameters. Extreme fluctuations in the graph suggest the battle may be something other than a simple attack, such as, for example, an envelopment mission, and that the outputs from the Automated Force Concentration Measurement System may not be meaningful. This graphic can be printed on the current Windows printer by pushing the Print button. Use the window menu to move, resize or close the graph.

Concentration Measures. Three rQ measures of concentration are calculated and displayed in the output window (see Figure 4) following a run. Each is the minimum value in meters computed while the Task Forces are between 8 and 4 kilometers distant from one another. The rQ(25) is the radius of a circle drawn to encompass 25% of the tank-killing systems of the attacking Task Force. The rQ(50) and rQ(75) are the comparable measures for 50% and 75%, respectively. For discussion of the use and the validation of these measures see Appendix A of this document.

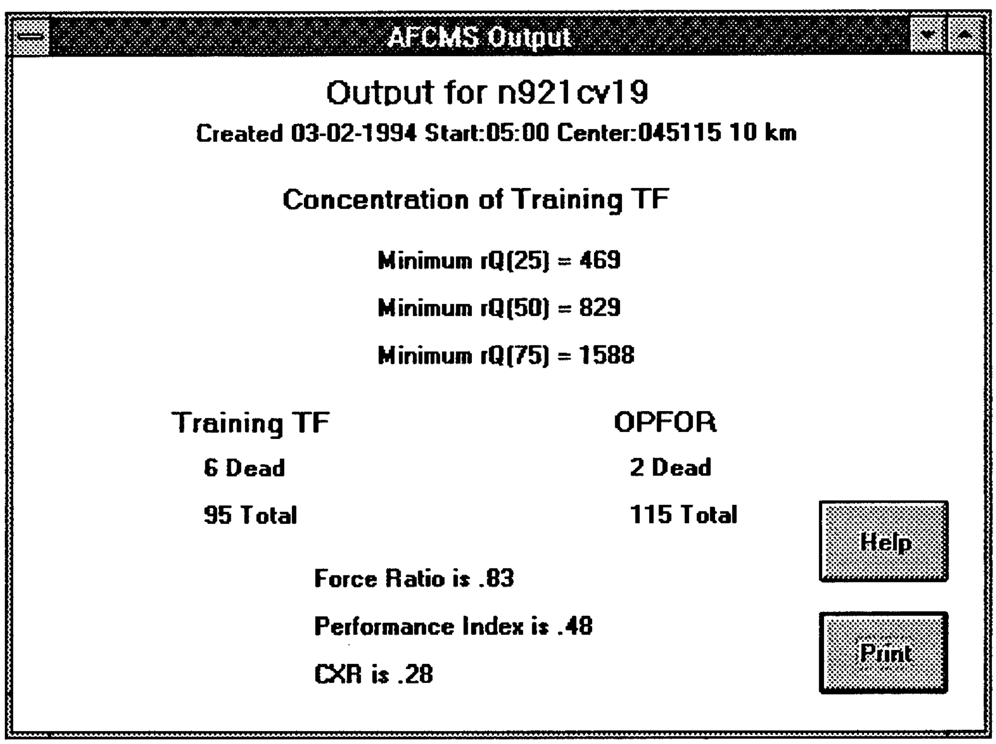

Figure 4. Output Window Showing Sample Results

Performance statistics. Shown in the output window following a run are the maximum number of Training Task Force (**T**) and Opposing Force Task Force (**O**) tank-killing players in proximity to the battle center observed in the processed data. Also shown are the number of killed Training Task Force players (**TK**) and Opposing Force players (**OK**). From these numbers, the Force Ratio is calculated as **T / O**. The performance measure is calculated as **(OK/O + (1 - TK/T)) / 2**. The casualty exchange ratio is calculated by **OK/O / TK/T**. The output window can be printed on the current Windows printer by selecting the Print button. Use the Windows window menu to move, resize or close the output display.

File output. Selection of this option will cause the Automated Force Concentration Measurement System to write both the input parameters and the outputs for the battle to a file MASSOUT.PUT. This information is written to the last line of the file. Values included are the mission identification, date created, specified battle center, proximity parameter, rQ(25), rQ(50), rQ(75), the force ratio, performance index and Casualty Exchange Ratio.

Printing This Manual. To print this manual on any printer supported by Windows, select Print from the File menu of Write after Help has been selected from the Automated Force Concentration Measurement System.